

WHAT IS CLAIMED IS:

1 1. A device for use with a piano comprising:
2 a housing configured to reside above a minor portion of a
3 keyboard of said piano, said housing being dimensioned to be non-intrusive
4 with respect to manipulations of said keyboard by a user of said piano; and
5 an array of signal generators mounted to said housing to
6 monitor activities of a plurality of keys of said keyboard, each said signal
7 generator being operatively associated with one of said keys and including
8 at least one light emitting device positioned to direct light so as to directly
9 impinge said associated key when said associated key is in a rest position,
10 each said signal generator further including at least one optical receiver
11 positioned with respect to said associated key and said light emitting device
12 of said each signal generator to detect movement of said associated key
13 relative to said rest position;
14 wherein said keys remain free from mechanical contact with
15 structure for enabling said signal generators to monitor said activities of said
16 keys.

1 2. The device of claim 1 wherein said array includes first signal generators
2 dedicated to white keys of said keyboard and includes second signal
3 generators dedicated to black keys of said keyboard, wherein:
4 (a) said at least one light emitting device and said at least one
5 optical receiver of each said first signal generator are cooperative to provide
6 an output signal that is indicative of intensity of light reflected from said white
7 key to which said first signal generator is dedicated; and
8 (b) said at least one light emitting device and said at least one
9 optical receiver of each said second signal generator are cooperative to
10 provide an output signal that is indicative of light blocked by said black key to
11 which said second signal generator is dedicated.

1 3. The device of claim 2 wherein each said second signal generator includes
2 an optical member cooperative with said at least one optical receiver to
3 provide an expanded field of view for detecting light from said at least one
4 light emitting device.

1 4. The device of claim 3 wherein said optical member is a cylindrical lens,
2 said at least one light emitting device being a single light emitting diode (LED).

1 5. The device of claim 2 wherein each said second signal generator includes
2 a plurality of said light emitting devices and a plurality of said optical receivers.

1 6. The device of claim 1 further comprising means for sensing positions of
2 pedals of said piano and generating electrical signals indicative of displace-
3 ments of said pedals.

1 7. The device of claim 6 wherein said means for sensing includes coils
2 having a one-to-one correspondence with said pedals, said coils being
3 positioned relative to said pedals to have inductances which vary with said
4 displacements of said pedals.

1 8. The device of claim 7 wherein said means for sensing further includes
2 a wireless transmitter enabled to transmit said electrical signals that are
3 indicative of displacements of said pedals.

1 9. The device of claim 1 further comprising computer processing connected
2 to receive output signals from said array of signal generators and to calculate
3 velocity data for displacements of each said key, said velocity data being
4 based upon sequencing within said output signals.

1 10. The device of claim 1 further comprising a flash detector configured to
2 detect light flashes in an area of said piano and to momentarily inhibit data
3 from said signal generators as a response thereto.

1 11. A device for use with a piano comprising:
2 a housing located at a back region of a keyboard of said piano
3 so as to be adjacent to a plurality of white keys and to extend between black
4 keys without influencing movement of said white and black keys when said
5 keyboard is in use;
6 a set of first light emitters disposed to project light from said
7 housing onto said white keys;
8 a set of first photo receivers positioned to detect portions of said
9 light reflected by said white keys, said first photo receivers being enabled to
10 generate electrical outputs representative of intensities of said detected
11 portions of light;
12 a set of second light emitters disposed to project light from said
13 housing onto said black keys when said black keys are at rest, while allowing
14 said light to pass above said black keys when said black keys are lowered;
15 a set of second photo receivers positioned to detect said light
16 passing above said black keys, said second photo receivers being enabled to
17 generate electrical outputs representative of intensities of said light; and
18 computational processing coupled to said first and second photo
19 receivers to receive said electrical outputs, said computational processing
20 being enabled to determine position and velocity data for said white and black
21 keys on a basis of said electrical outputs.

1 12. The device of claim 11 further comprising piano pedal sensors located to
2 generate position information that is specific to pedals of said piano, said
3 computational processing being configured to form signals compatible with an
4 external apparatus using a Musical Instrument Digital Interface (MIDI) format.

1 13. The device of claim 11 further comprising indicators assigned to said
2 white and black keys, said indicators being connected to said housing to be
3 visible by a user of said piano, said computational processing being con-
4 figured to transmit signals to said indicators in predetermined sequences for
5 prompting said using in manipulating said white and black keys.

1 14. A method of non-intrusively detecting manipulations of a keyboard
2 comprising:
3 monitoring reflected light which is reflected by individual white
4 keys of said keyboard in order to distinguish times in which said white keys
5 are at rest from times in which said white keys are displaced;
6 monitoring unblocked light which is unblocked by individual
7 black keys of said keyboard in order to distinguish times in which said black
8 keys are at rest from times in which said black keys are displaced; and
9 determining position and velocity data for said individual white
10 and black keys on a basis of variations in intensities of said reflected and
11 unblocked light.

1 15. The method of claim 14 wherein, for each said white key, monitoring said
2 reflected light includes projecting a first light beam to impinge said white key
3 and generating a signal indicative of a portion of said first light beam reflected
4 by said white key.

1 16. The method of claim 15 wherein, for each said black key, monitoring said
2 unblocked light includes projecting a second light beam to impinge said black
3 key when said black key is in a rest position and generating a signal indicative
4 of a portion of said second light beam which propagates to at least one
5 aligned photo receiver.

1 17. The method of claim 16 wherein monitoring said unblocked light further
2 includes assigning a plurality of said aligned photo receivers to each said
3 black key, so as to provide a wider field of view in generating said signal.

1 18. The method of claim 14 further comprising using electronic monitoring
2 to sense mechanical manipulations of pedals of said piano, said steps of
3 monitoring and electronic monitoring being executed without mechanically
4 affecting said pedals and said white and black keys.

1 19. The method of claim 18 wherein using electronic monitoring to sense
2 said mechanical manipulations includes positioning a coil adjacent to each
3 said pedal and sensing inductances of said coils.

1 20. The method of claim 19 wherein said steps of electronic monitoring
2 and determining position and velocity data contribute to generating MIDI-
3 compatible signals representative of movements of said pedals and said
4 white and black keys.